

Privacy Implications of Real Time Bidding

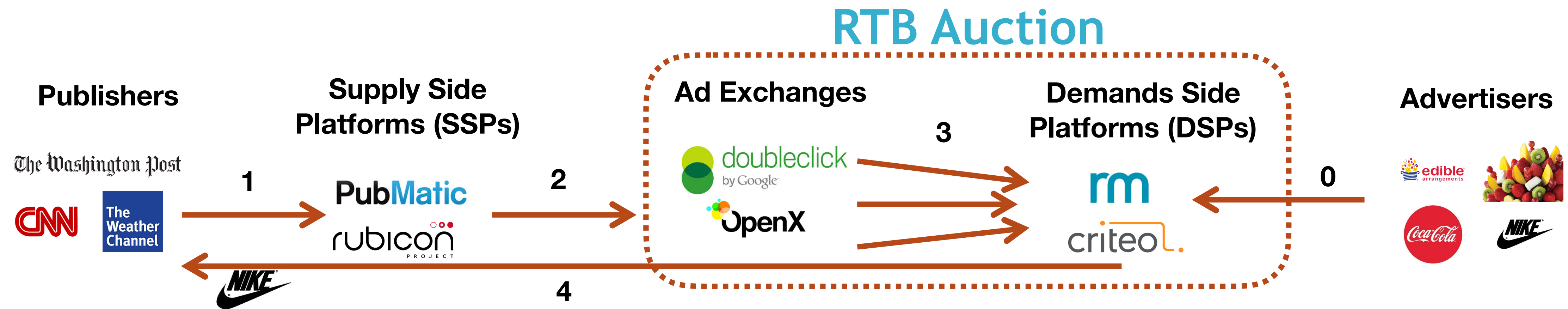
Muhammad Ahmad Bashir



Northeastern University
**Khoury College of
Computer Sciences**

Real Time Bidding (RTB)

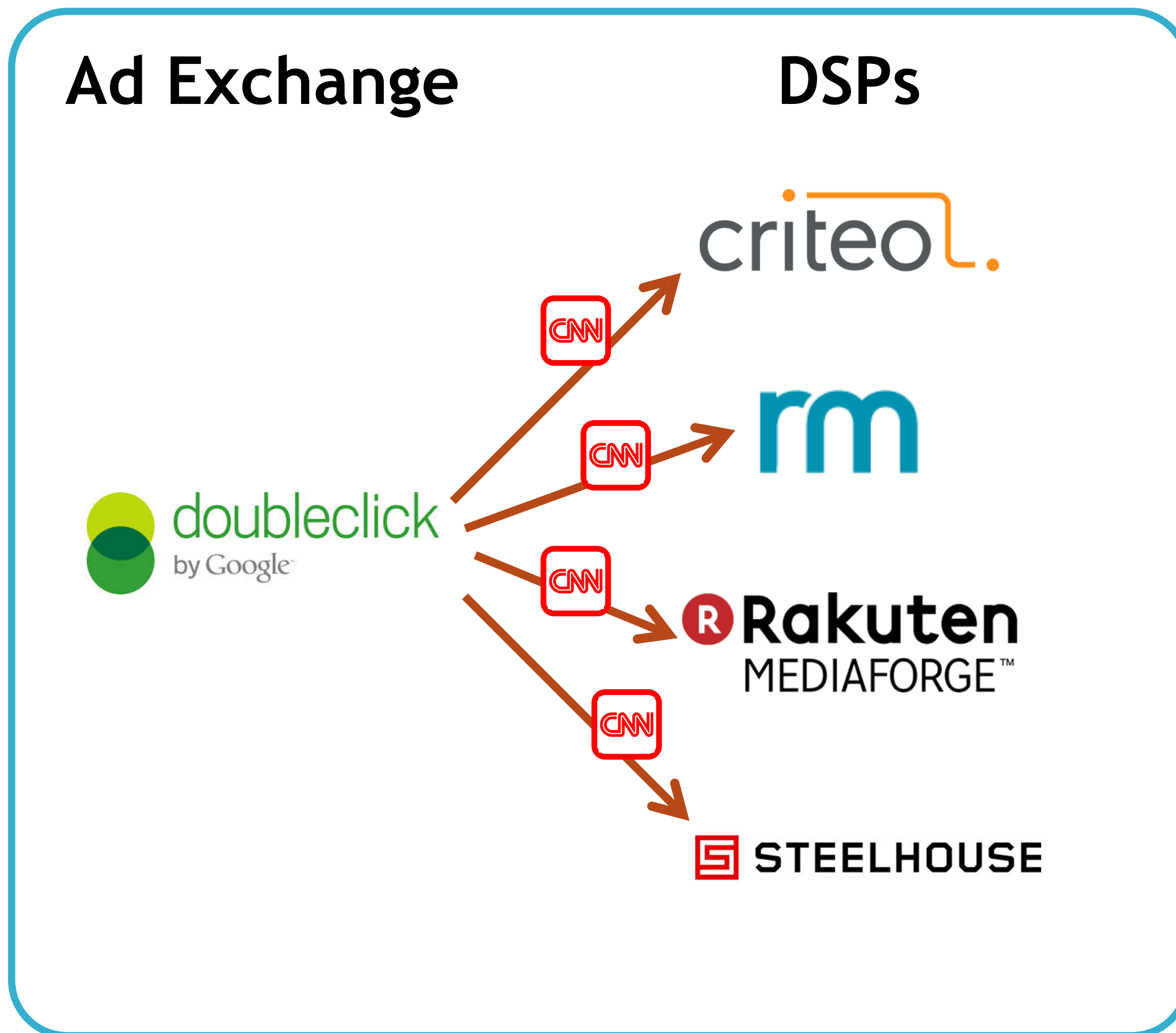
Process of buying and selling ad impressions through real-time auctions.



- SSPs work with publishers to maximize their revenue.
- Ad Exchanges run auctions.
- DSPs place bids on behalf of advertisers.
 - DSPs can analyze context and can bid according to the information they have.

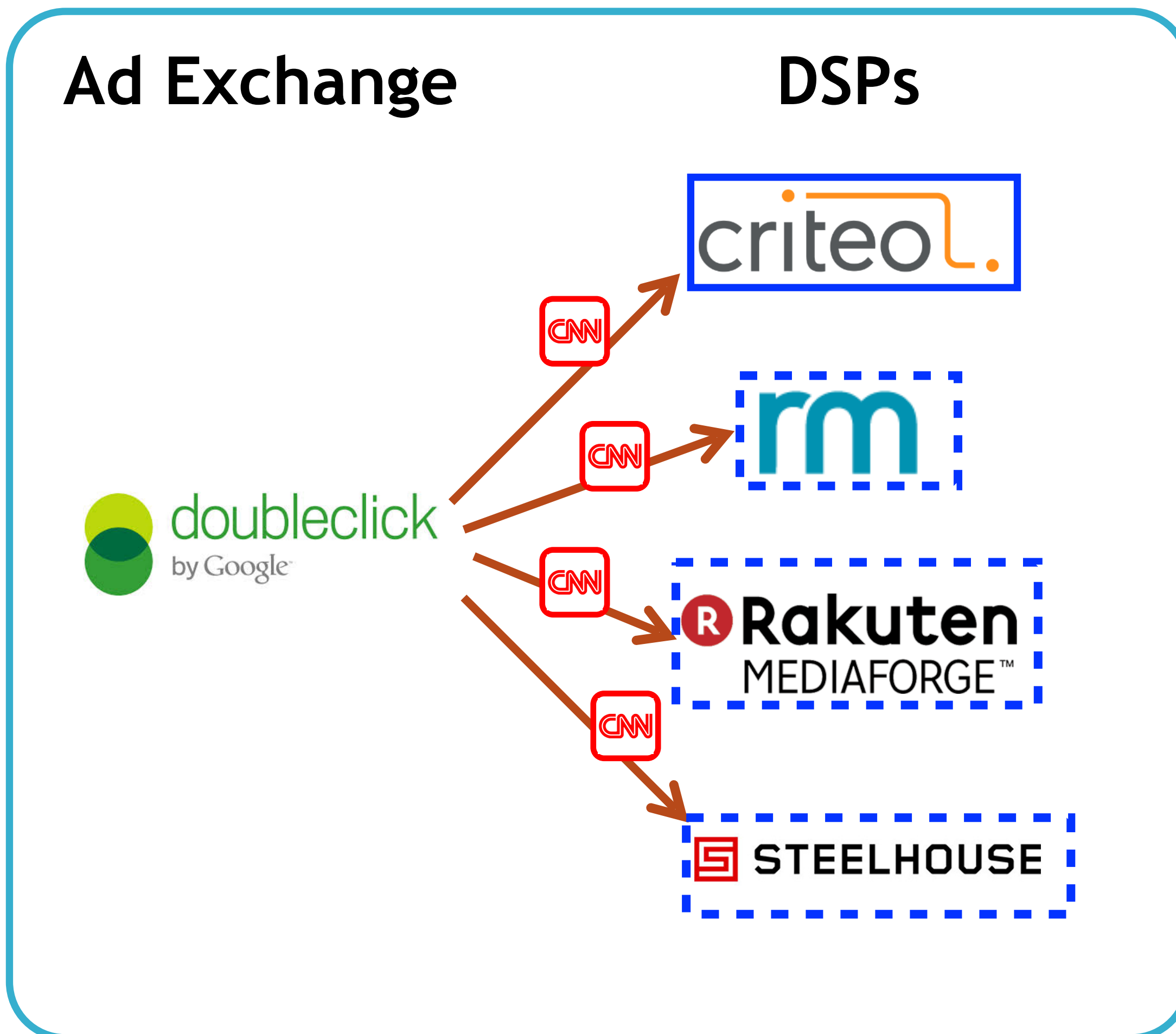
Close Collaboration Among Ad Networks

RTB Auction



Close Collaboration Among Ad Networks

RTB Auction



Key Takeaway

- In RTB, All DSP partners view user impression
- Losing DSPs also learn some information

Diffusion of User Tracking Data in the Advertising Ecosystem

Goal: Model the Diffusion of Impressions in the Advertising Ecosystem

Taking RTB into account

Key Questions:

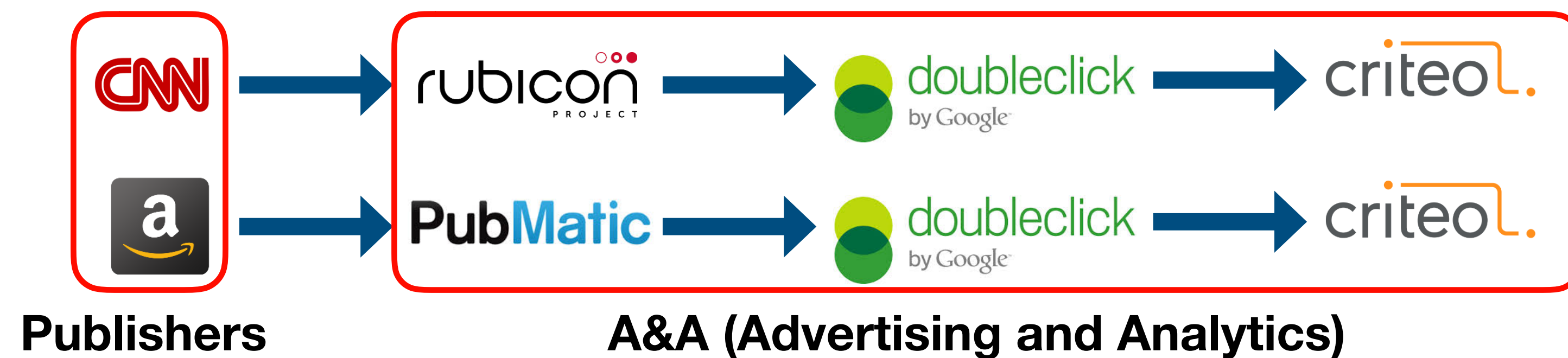
1. What fraction of user impressions are viewed by ad companies?
2. How much ad and tracker blocking extensions help?

Key Terms:

1. **Impressions:** Page Visits
2. **Publishers:** First party websites visited by users (e.g. cnn, bbc, espn)
3. **A&A:** Advertising and Analytics related companies / domains

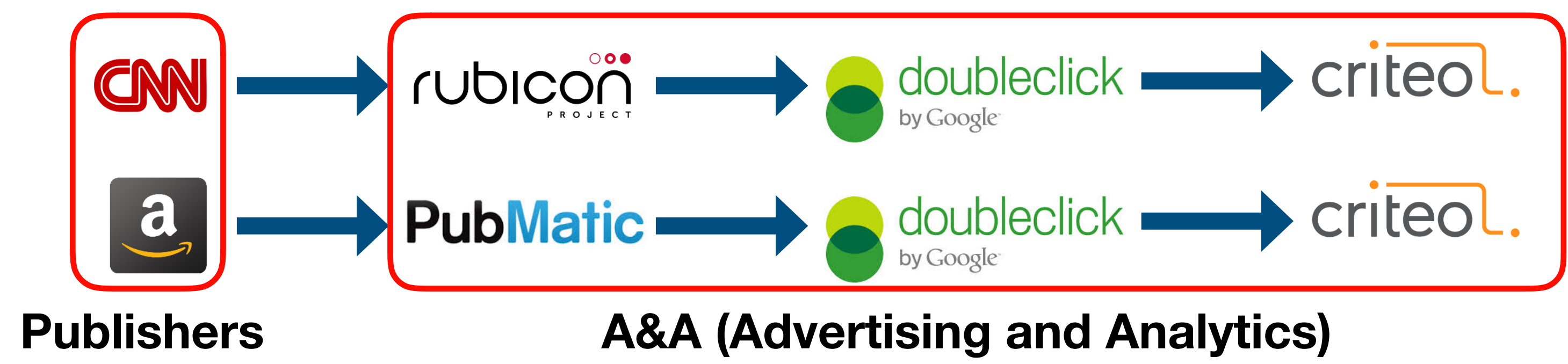
Inclusion (Chain) of Resources on the Web

Inclusion Chains From Prior Data



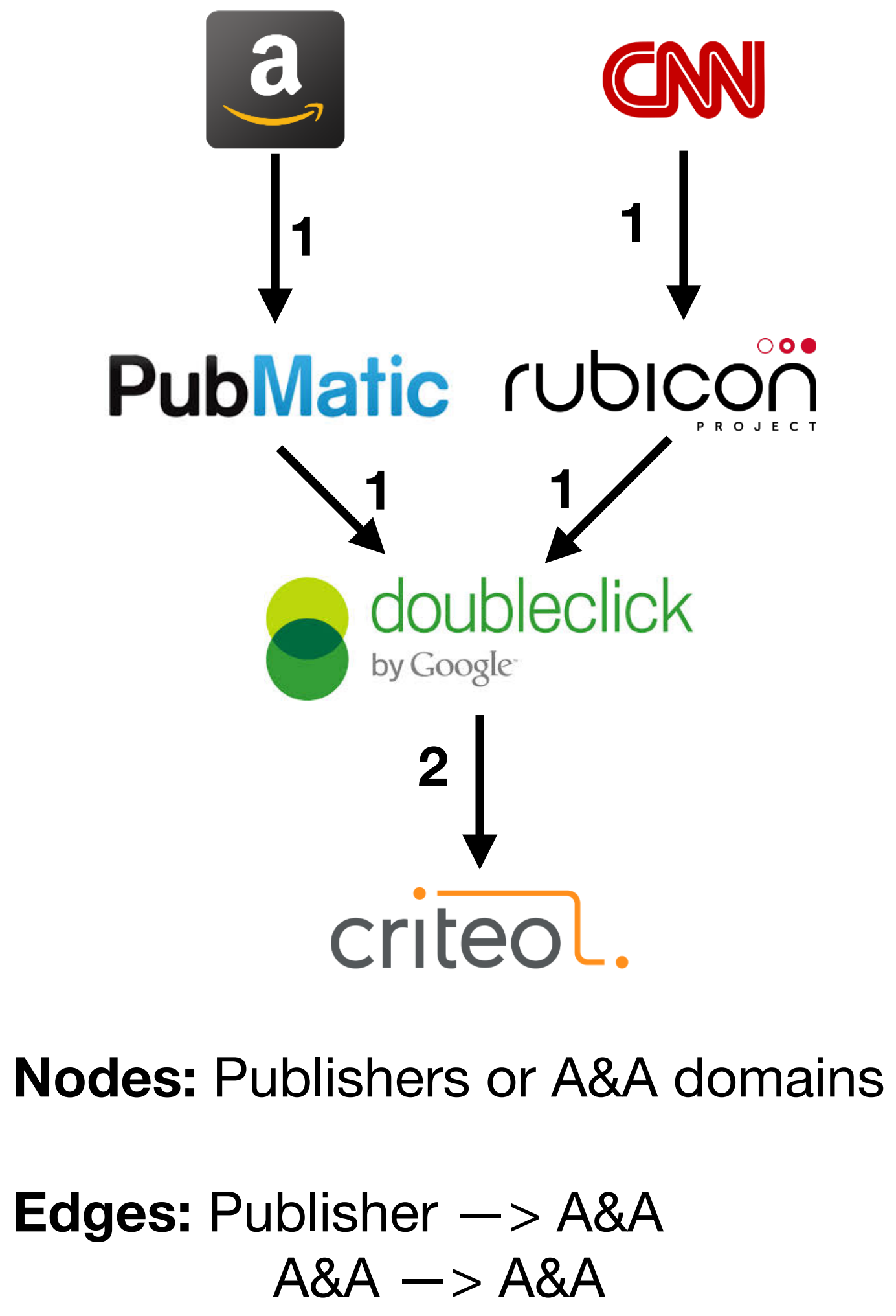
From Chains to Graph

Inclusion Chains From Prior Data




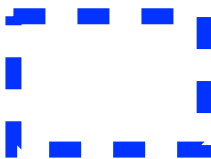
- Nodes:
- **Total:** ~1.9K
 - **A&A:** ~1K
- Edges:
- **Total:** ~26K
 - **Pub —> A&A:** ~10.5K
 - **A&A —> A&A:** ~15.5K

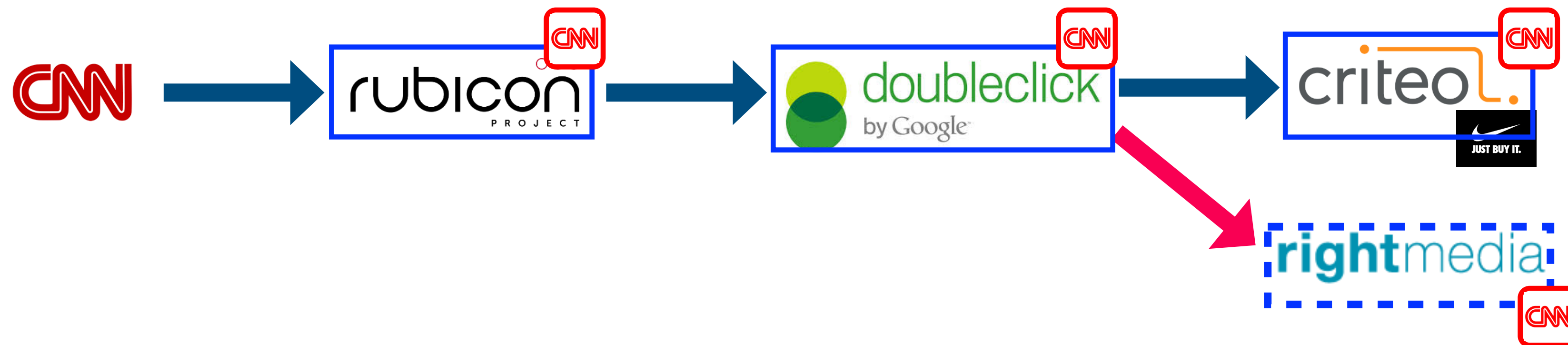
Graph Representation



We Ran Simulations to Understand Propagation of Tracking Data

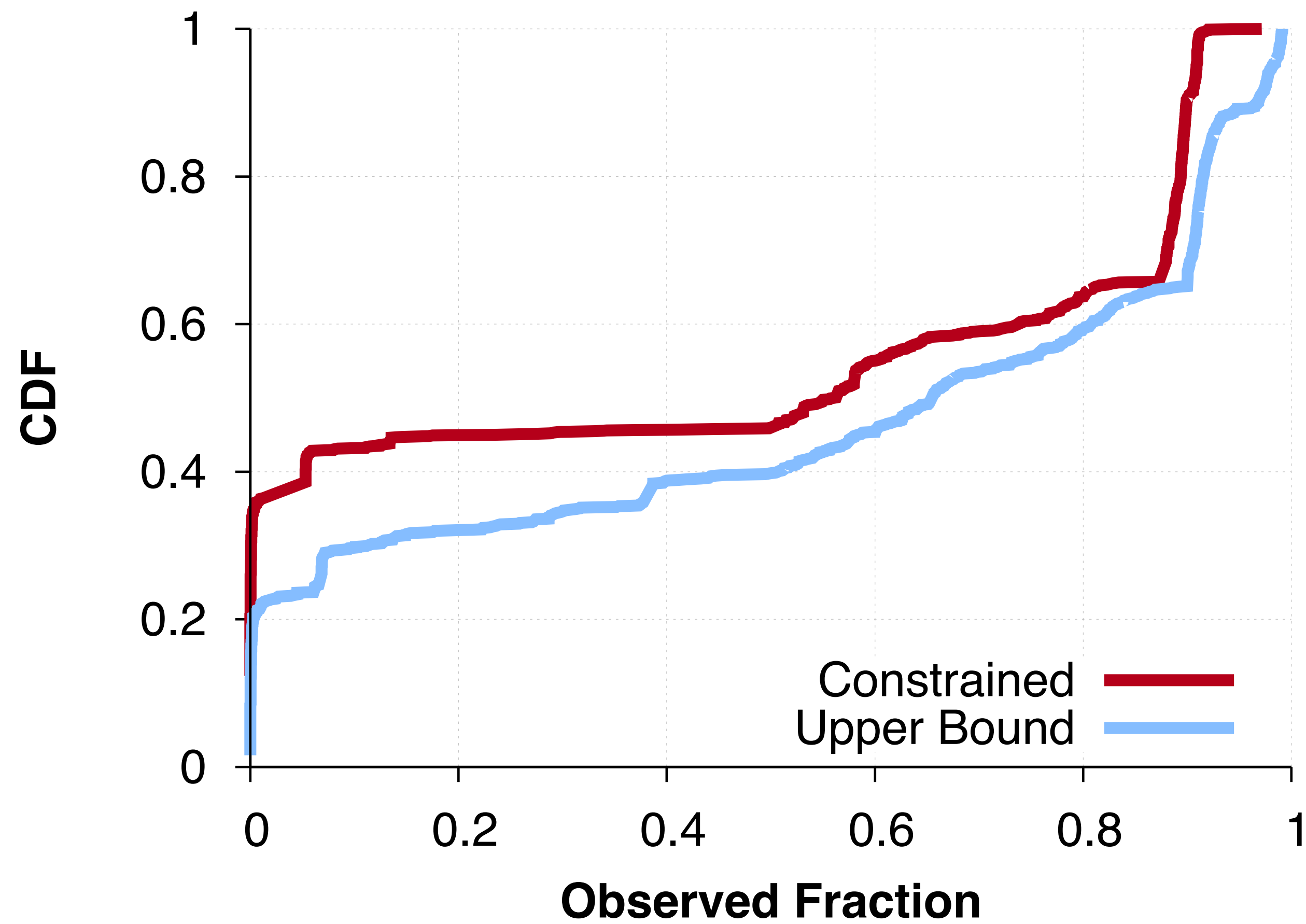
We simulate browsing traces for 200 users using method from [1].

1. User generates an impression on N selected publishers.
2. Impressions are forwarded to A&A domains via:
 - A. **Direct Propagation:** 
 - Present on publisher or won RTB auction. **Observable** (goes through the browser)
 - B. **Indirect Propagation:** 
 - A&A domains learn impressions through RTB participation. **Non-observable**
3. RTB winner is decided based on probability (function of edge weights).

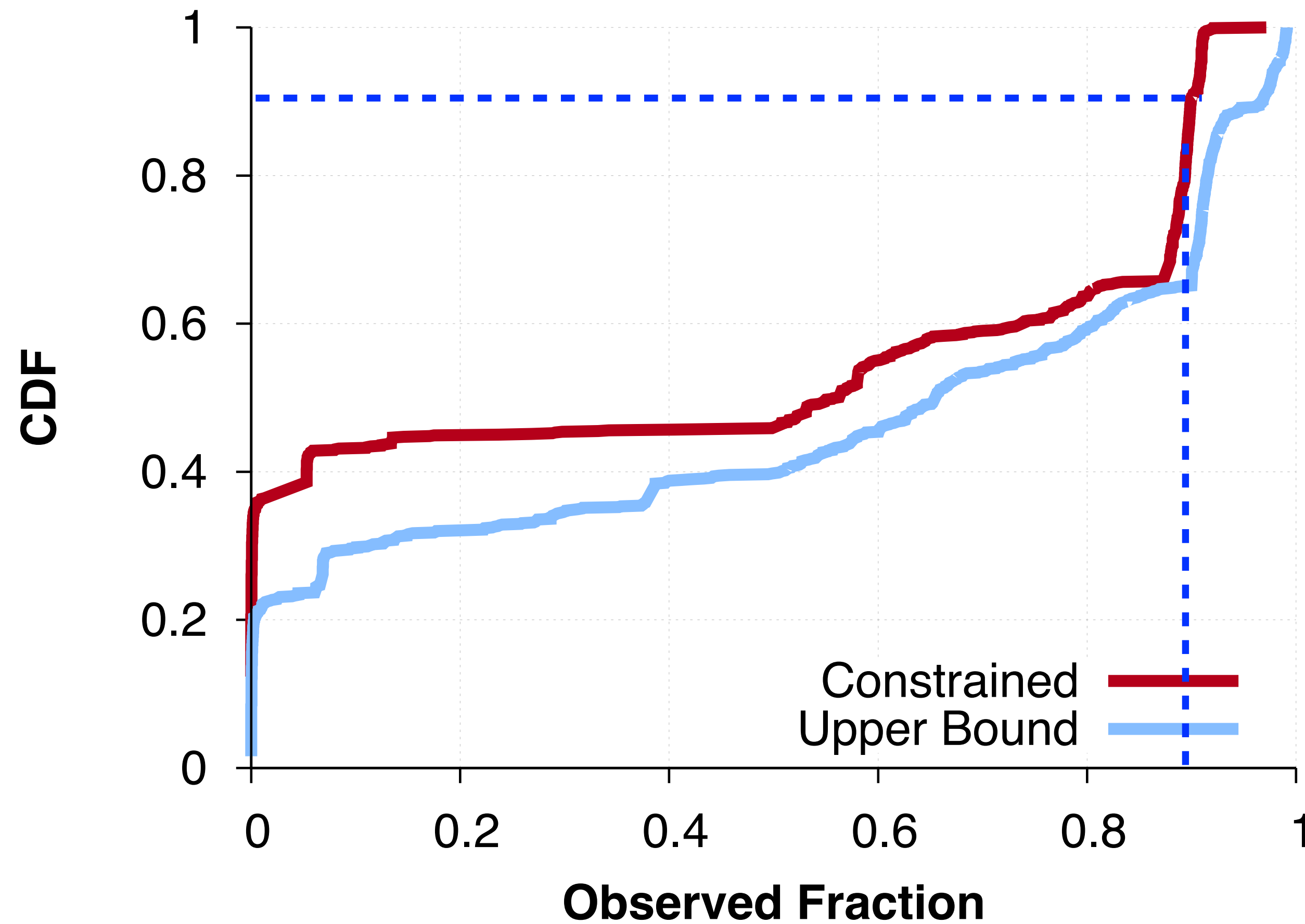


[1]. Burken et al. User centric walk: An integrated approach for modeling the browsing behavior of users on the web. ASS 2005

Impressions Observed by A&A Domains



Impressions Observed by A&A Domains



Take Away

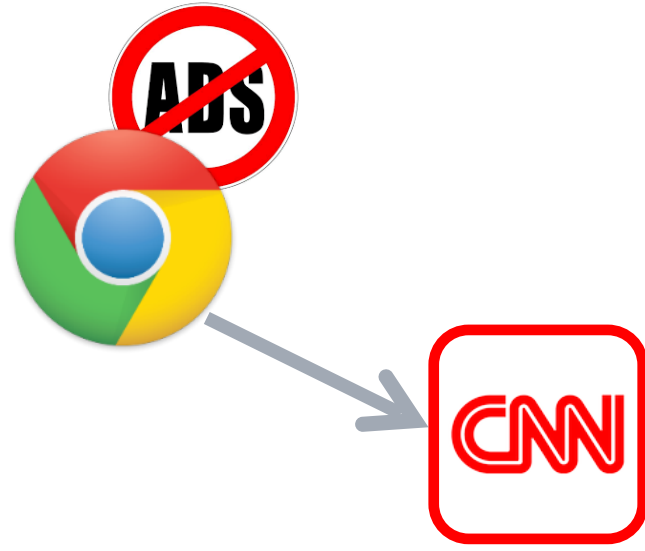
1. Constrained model is very close to Upper Bound
2. 10% A&A see more than 90% of impressions

Simulating Effect of Blocking Extensions



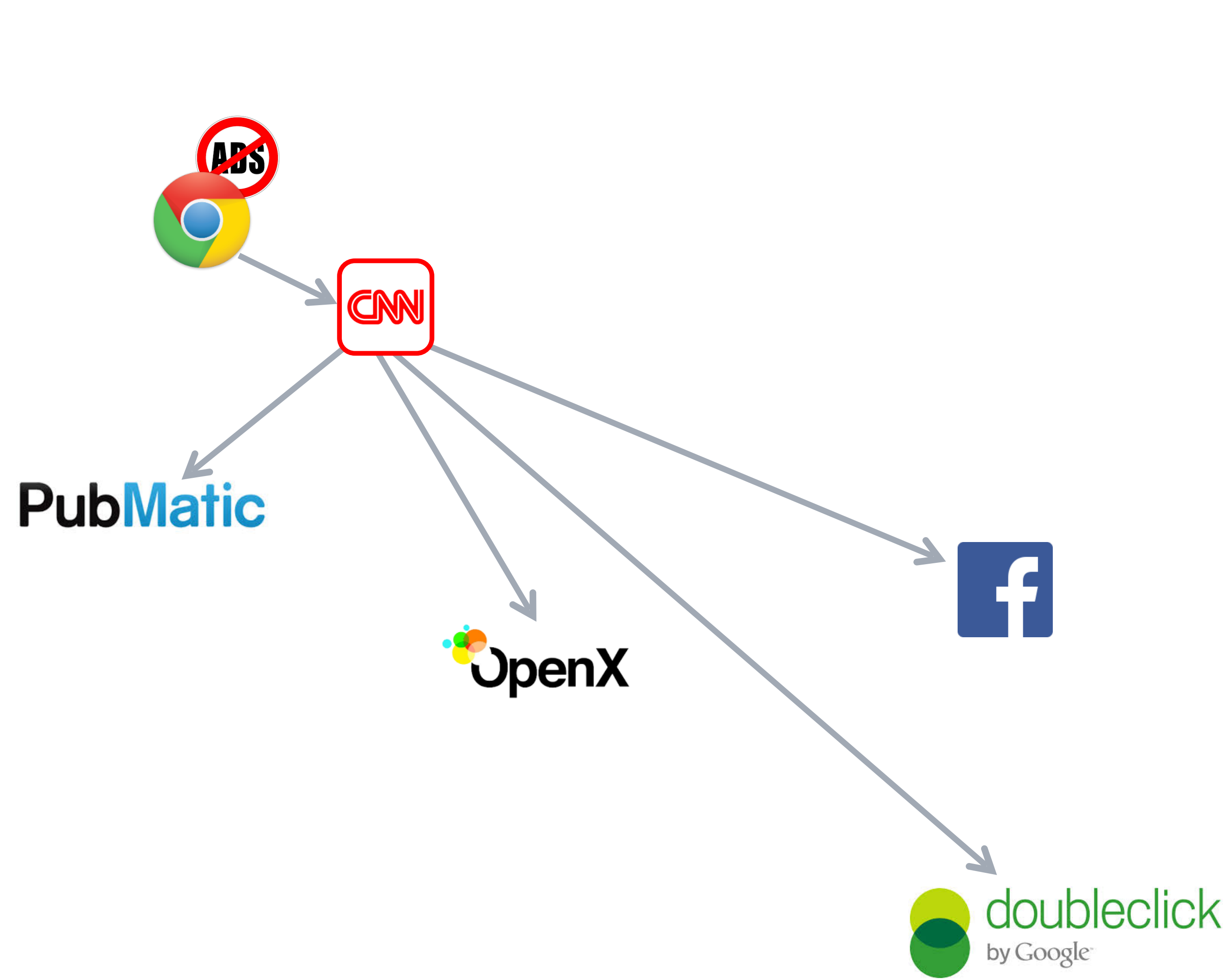
DoubleClick
OpenX
PubMatic

Simulating Effect of Blocking Extensions



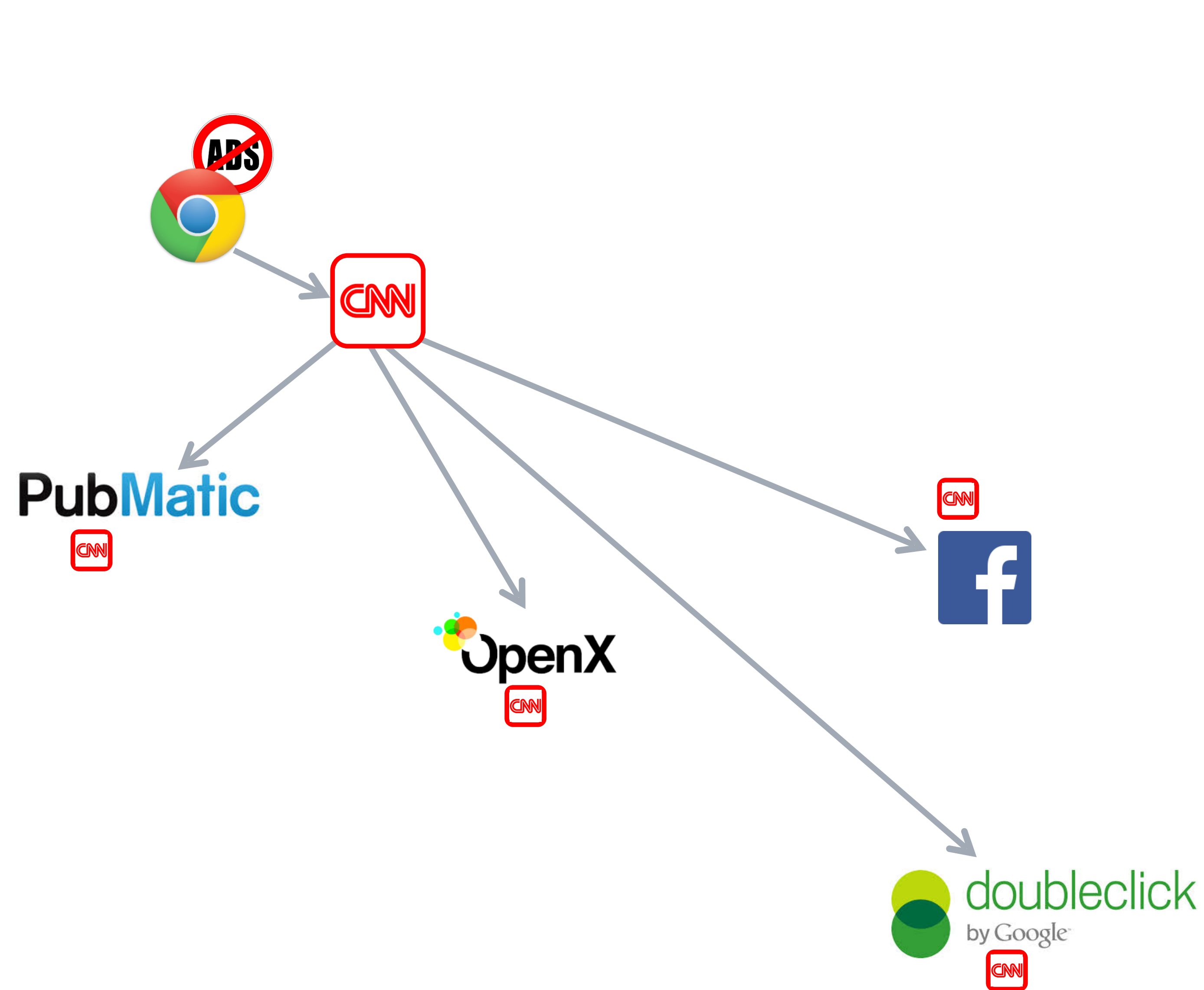
DoubleClick
OpenX
PubMatic

Simulating Effect of Blocking Extensions



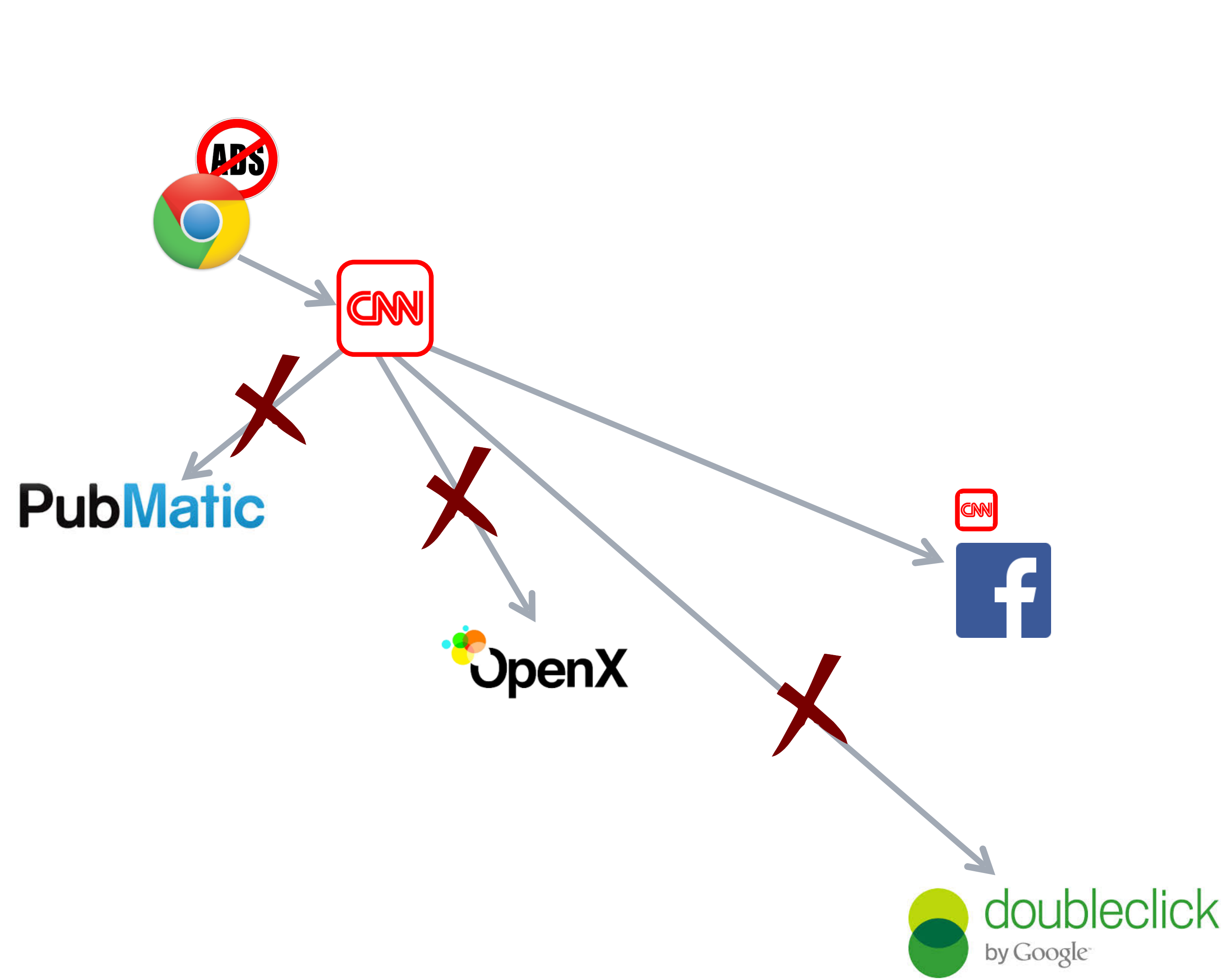
DoubleClick
OpenX
PubMatic

Simulating Effect of Blocking Extensions



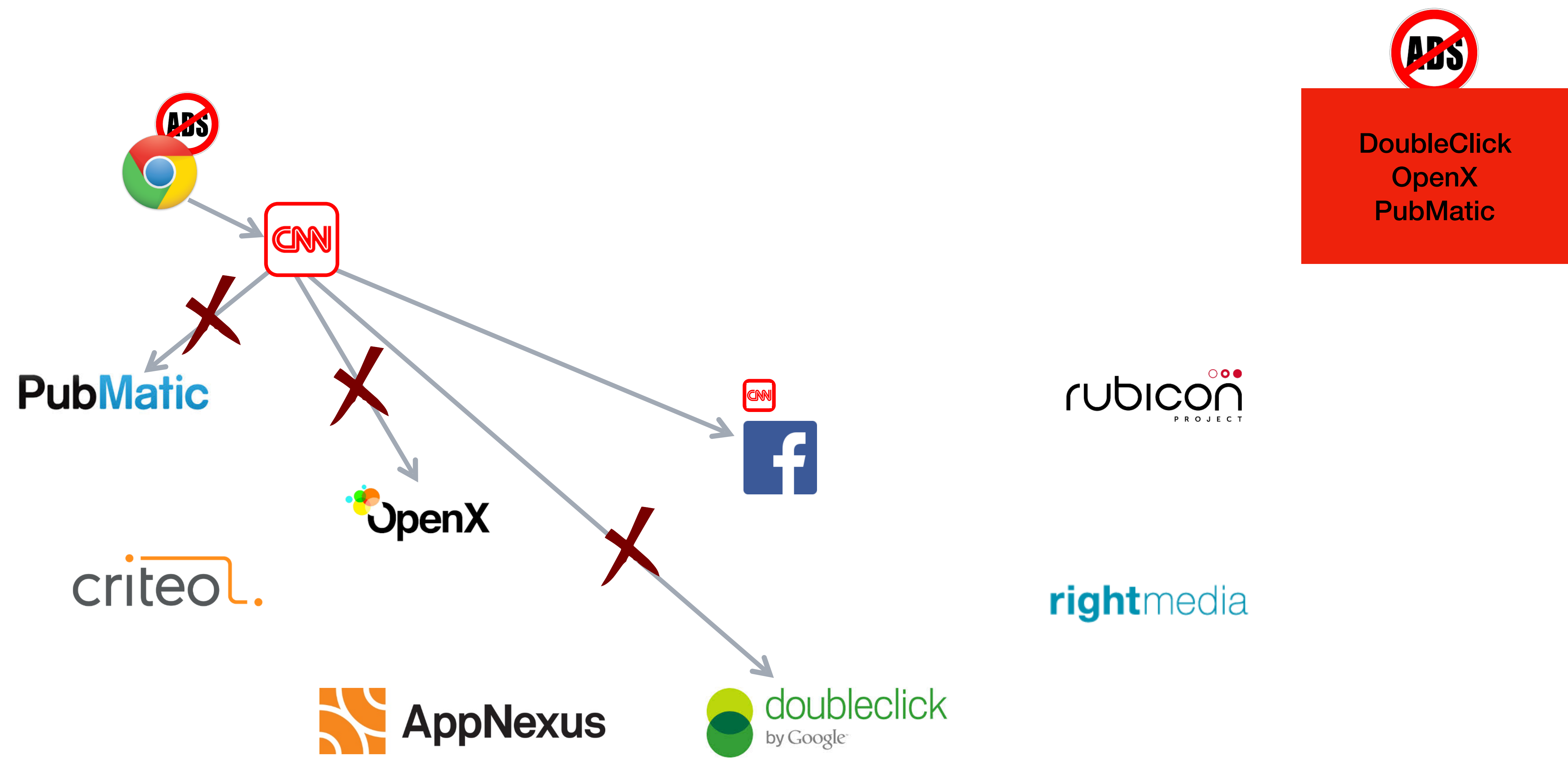
DoubleClick
OpenX
PubMatic

Simulating Effect of Blocking Extensions

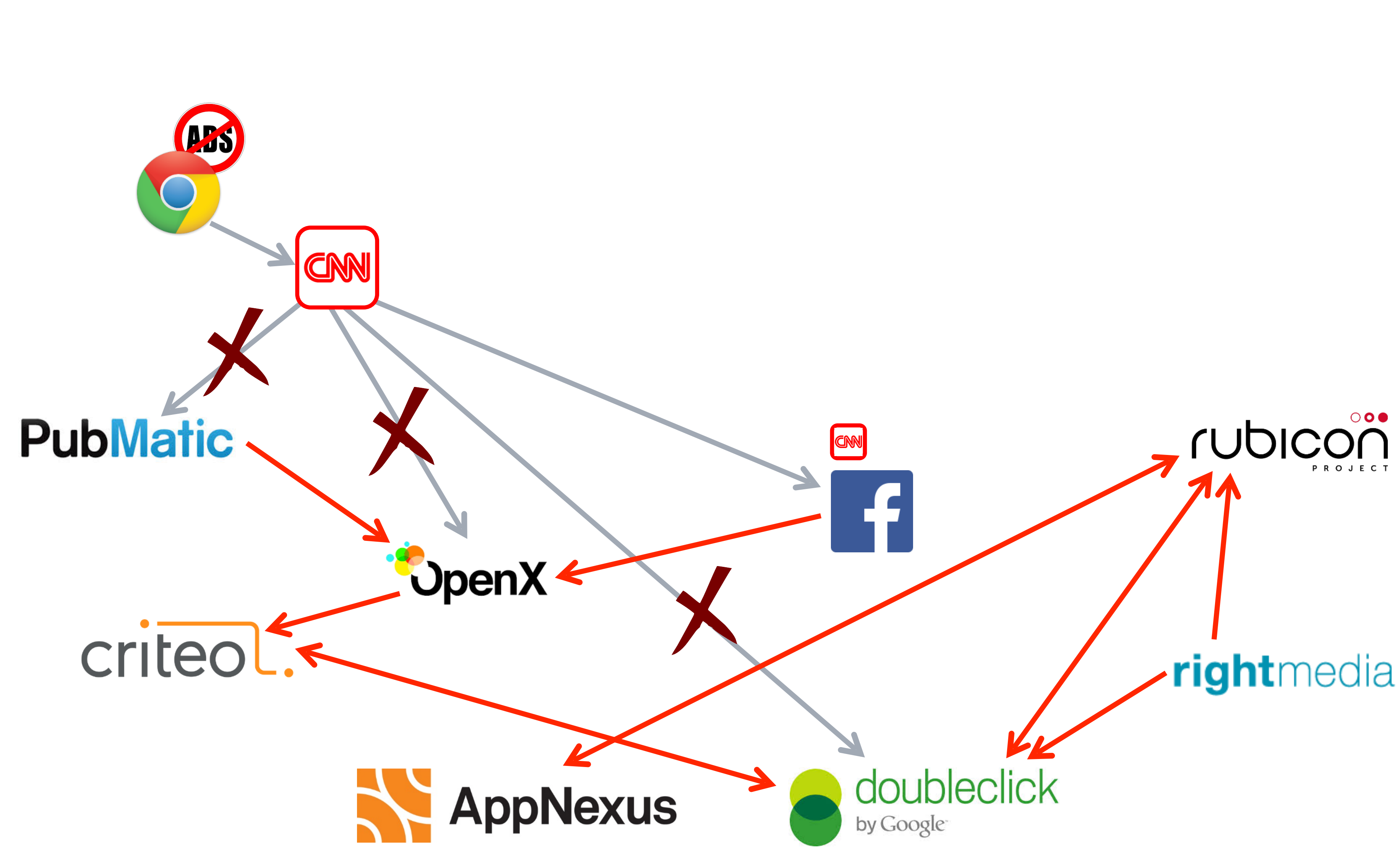


DoubleClick
OpenX
PubMatic

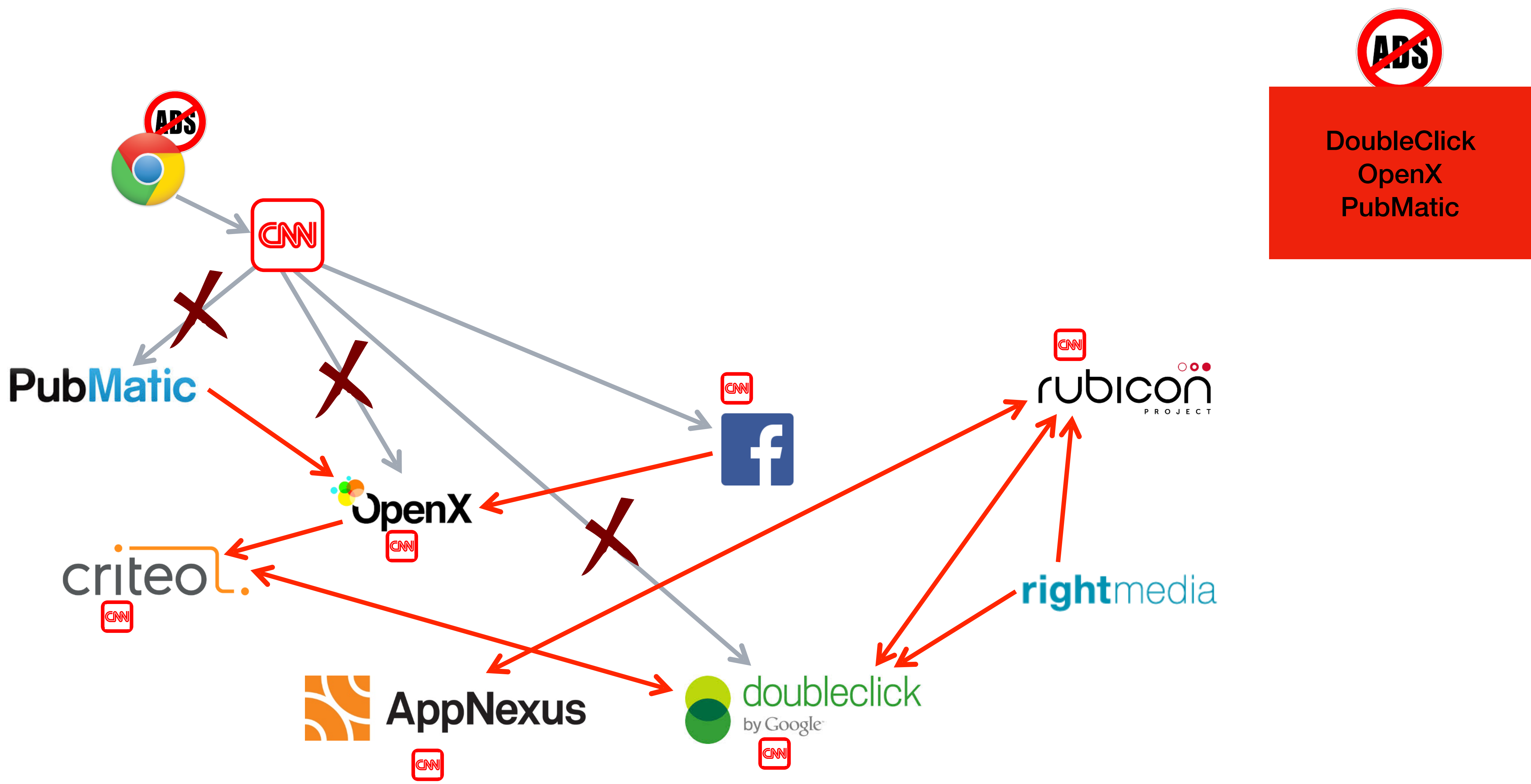
Simulating Effect of Blocking Extensions



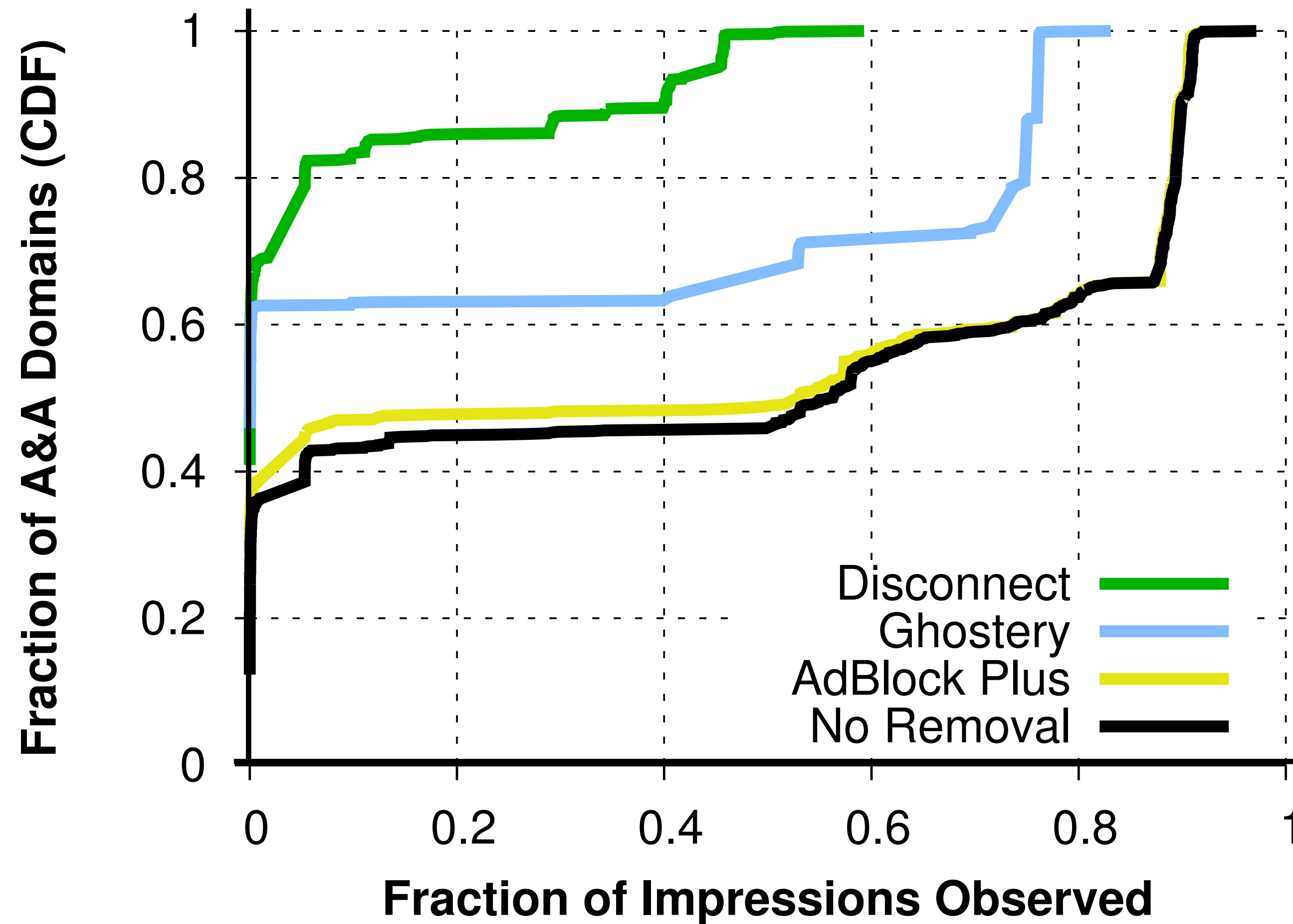
Simulating Effect of Blocking Extensions



Simulating Effect of Blocking Extensions



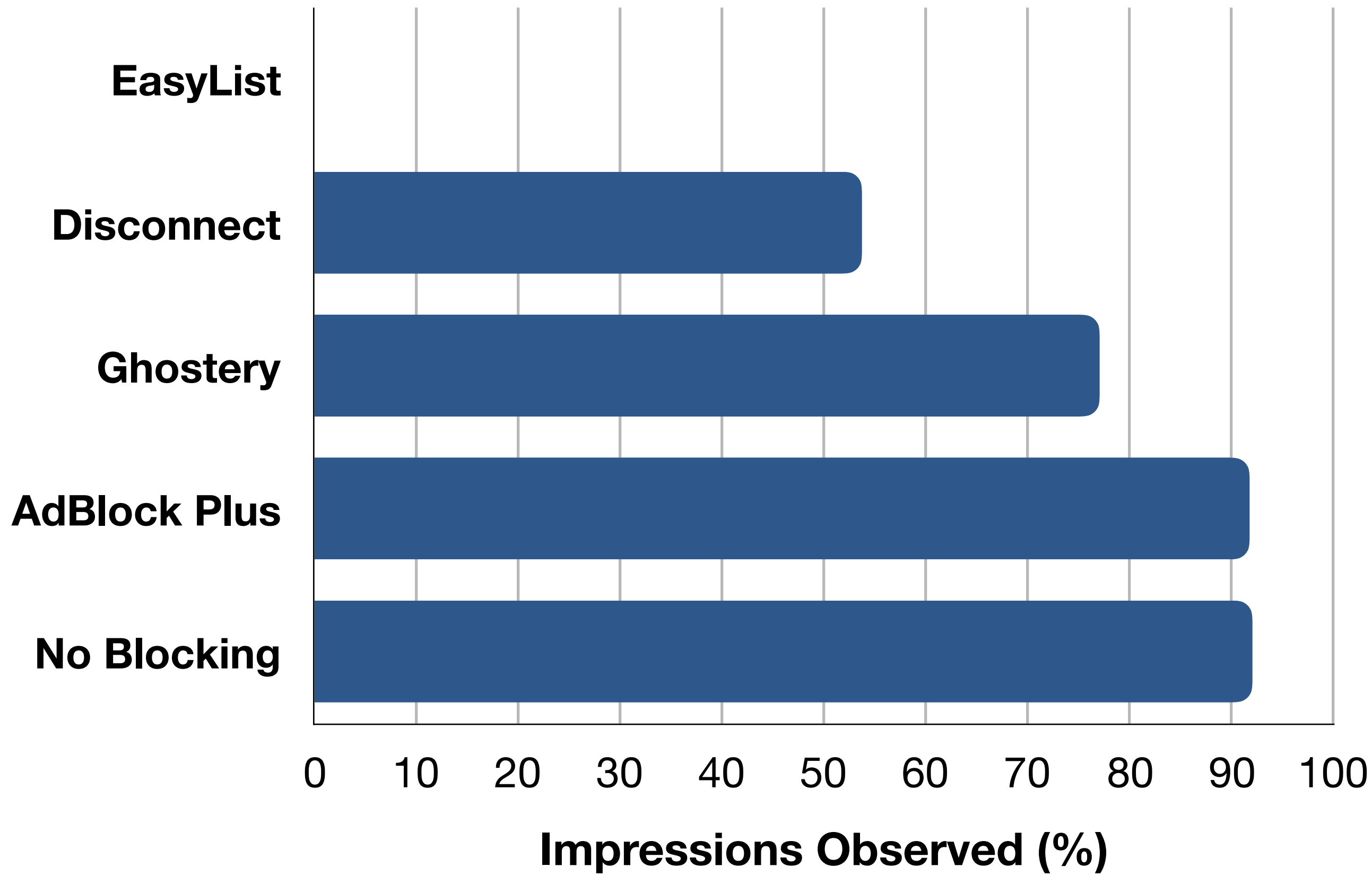
Impressions Observed With Blocking



Take Away

- Disconnect list is most effective.
- ABP is not effective at all due to Acceptable Ads program.
- Due to RTB, impressions are leaked to A&A domains even with blocking extensions.

Top 10 Domains Observing Impressions



Domain	Impression %
google-analytics	97.0
youtube	91.7
quantserve	91.6
scorecardresearch	91.6
skimresources	91.3
twitter	91.1
pinterest	91.0
addthis	90.0
criteo	90.0
bluekai	90.8

Top 10 domains with most observed impressions under AdBlock Plus

Top 10 domains can view majority of user impressions even with (most) blocking extensions installed

Key Takeaways

- Real Time Bidding (RTB) has changed the landscape of modern ad ecosystem
- A&A companies collaborate closely together to participate in RTB
 - Privacy leakage is not isolated to individual ad networks / exchanges
 - Due to RTB, impressions can leak to A&A domains even with blocking extensions
- Need to carefully think about the implications of RTB while studying online tracking

Diffusion of User Tracking Data in the Online Advertising Ecosystem
(PETS 2018)

Questions?
ahmad@ccs.neu.edu